IN THE SPECIFICATION

In accordance with 37 CFR 1.121(b), the following paragraphs of the specification as rewritten by the foregoing amendments show all changes made relative to the as-filed version of the specification.

At page 1, the 1st paragraph entitled "RELATED APPLICATIONS" is amended as follows:

This application is related to co-pending application 09/905,528, filed August 22, 2001, which is a continuation of Serial No. 09/333,172, filed June 14, 1999, now issued as Patent No. 6,353,688, which is a continuation-in-part of application Serial No. 08/073,929, filed June 8, 1993, now issued as Patent No. 5,912,993. The subject matter of these applications is incorporated herein by reference.

At page 2, the last paragraph beginning at line 30 is amended as follows:

While minimum complexity has a clear theoretical advantage, it can be computationally intensive, making it difficult to reach a conclusion in a period of time that would permit practical application, unless the parameterization of the system in known in advance. A representation of a system requires a model language that decomposes it into smaller units, and one must choose between a vast number of languages, i.e., means for expressing the algorithm. Even after a language is chosen, the set of all possible parameterizations with that language can become too large to search practically. For example, consider modeling the covariance matrix of a system of N variables with P parameters, such as discussed above relative to the Negishi patent. Standard estimates assume that all the elements of the covariance matrix are significant, i.e., each variable is correlated with every other variable. This gives N(N+1)/2 independent elements of the covariance matrix (after accounting for the symmetry of the covariance matrix). A minimum complexity model [seek] seeks to represent these N(N+1)/2 numbers by a much smaller number P of parameters. One simple approach would be to set to zero all but P of the N(N+1)/2 elements. [But] However, the choice of P elements among N(N+1)/2 is a combinatorially large problem and an exhaustive evaluation of all of the possibilities is not practical. In addition, the covariance matrix must be positive definite, and this constraint

further restricts the possible parameterizations. It is clear therefore, that a practical method is needed[,] which will find a minimum-complexity model without [having exhaustively to] requiring an exhaustive search of all possible parameterizations.

At page 5, the 5th paragraph beginning at line 16 is amended as follows:

The Algebron™ system and method utilize a software program stored in a personal computer (PC) to determine the minimum number of factors required to account for the input data by seeking an approximate minimum complexity model[]] that is achievable in a limited period of time using a reasonable number of computational steps. In an exemplary embodiment for estimating covariance in the daily returns of financial securities, the method generates a positive-definite estimate of the elements of a covariance matrix consistent with the input data. However, the method minimizes complexity of the covariance matrix by assuming that the number of independent parameters is likely to be much smaller that the number of elements in the covariance matrix. The Algebron™ method minimizes the number of independent parameters by describing each variable as a linear combination of independent factors and a part that fluctuates independently. The simplest model for the covariance matrix is selected so that it fits the data to within a specified quality as determined by the selected goodness-of-fit (GOF) criterion. In this case, the GOF criterion is the logarithm of the likelihood function.

At page 8, the last paragraph beginning at line 21 is amended as follows:

The data set chosen for this example presents tremendous problems for standard analysis techniques. For example, in the time series of the returns, two-thirds of all of the possible data are missing because of gaps in the trading or the reporting of the returns. Hence, direct calculation of the covariance matrix is impossible. Some form for sophisticated algebraic modeling is essential in order to estimate the covariance. In this example, the Algebron™ model of the covariance matrix required 8 factors and a total of 152 off-diagonal, nonzero loading matrix coefficients. This compares to standard factor analysis methods that would use 924 off-diagonal, nonzero loading matrix elements for this number of factors. As with Example 1, the presence of [these additional] the large number

of unnecessary model parameters grossly affects the determination of the remaining required parameters. Hence, the ten-fold reduction in model complexity afforded by the Algebron™ method leads to a tremendous improvement in accuracy.

Amendments in the Claims

In accordance with 37 CFR 1.121(c), the following claims as rewritten by the foregoing amendments show all changes made relative to the as-filed version of the claims.

2. A computer-based method for prediction of behavior in a [complex] financial system using [measured] financial return data [comprising a plurality of data points collected over time and a set of independent variables], the method comprising the steps of:

(a) inputting the [plurality of data points] financial return data and [the] a set of independent variables corresponding to properties of the financial system into a computer, wherein the financial return data comprises a plurality of data points collected over time;

(b) defining a first subset of independent variables within the set of independent variables comprising a least quantity of independent variables estimated to fit the [measured] financial return data;

(c) determining a goodness-of-fit to the measured data [at a predetermined minimum level] according to a selected goodness-of-fit criterion for each independent variable of the first subset of independent variables;

(d) [eliminating] culling each independent variable within the first subset whose presence or elimination fails to change the goodness-of-fit [at the predetermined minimum level];

(e) defining a next subset of independent variables larger than the first subset of independent variables;

(f) adding the next subset of independent variables to a remaining group of the first subset of independent variables to define a combined group of independent variables;

(g) determining the goodness-of-fit to the [measured] financial return data [at the predetermined minimum] for the combined group of independent variables;

(h) [eliminating] culling each independent variable of the combined group of independent variables whose presence or elimination fails to change the goodness-of-fit [at the predetermined minimum level];

(i) repeating steps (e) through (h) until the goodness-of-fit to the [measured] financial return data meets the selected goodness-of-fit criterion [predetermined minimum level] in a final iteration; and

(j) providing an output comprising the combined group of independent variables remaining after the final iteration, wherein the remaining independent variables comprise the smallest subset of independent variables that fits the [measured] financial return data. *(amended)*

3. The computer-based method of claim 2, wherein the [plurality of data points] financial return data comprises daily returns of financial securities, wherein the daily returns have unknown covariances. *(amended)*

4. The computer-based method of claim 3, wherein the daily returns comprise a linear combination of unknown factors and a part that fluctuates independently corresponding to noise, according to the relationship

$$X_\alpha = \sum_{\beta=1}^{k} \Lambda_{\alpha,\beta} f_\beta + N_\alpha ,$$

where α and β are financial securities, $\underline{X}_\alpha$ is the daily return for financial security α, f_β is an unknown factor, $\Lambda_{\alpha,\beta}$ is a loading matrix, and N_α is the noise. *(amended)*

8. A system for prediction of behavior in a [complex] financial system using [measured] financial return data [comprising a plurality of data points and a set of independent variables], the system comprising:

a computer having an input for receiving the return data comprising a plurality of data points collected over a period of time and [the] a set of independent variables corresponding to properties of the financial system;

computer software contained within the computer for performing a plurality of iterations, each iteration comprising identifying a subset of independent variables within the set of independent variables and determining a goodness of fit to the measured data [at a predetermined minimum level] according to a selected goodness-of-fit criterion for each independent variable of the subset, eliminating each independent variable within the subset whose presence or elimination fails to change the goodness-of-fit at the predetermined minimum level, and combining, after the plurality of iterations, remaining independent

variables to identify the smallest subset of independent variables that fits the [measured] financial return data to generate an output;

wherein the plurality of iterations utilizes increasingly larger subsets of independent variables. (*amended*)

9. The system of claim 8, wherein the [plurality of data points] financial return data comprises daily returns of financial securities, wherein the daily returns have unknown covariances. (*amended*)

10. The system of claim 9, wherein the daily returns comprise a linear combination of unknown factors and a part that fluctuates independently corresponding to noise, according to the relationship

$$X_{\alpha} = \sum_{\beta=1}^{k} \Lambda_{\alpha,\beta} f_{\beta} + N_{\alpha},$$

where α and ß are financial securities, X_α is the daily return for financial security α, $f_ß$ is an unknown factor, $\Lambda_{\alpha,ß}$ is a loading matrix, and N_α is the noise. (*amended*)

14. A computer-based method for prediction of behavior in a financial system comprising:

estimating a covariance matrix of the financial system comprising a plurality of financial returns and a plurality of factors using a subset of the plurality of factors, wherein the subset comprises the minimum number of factors capable of describing the plurality of financial returns, wherein the subset is selected by iteratively modeling each financial return as a linear combination of unknown factors and a noise factor starting with zero factors and adding one factor with each iteration until a model is identified for which no further improvement in a fit of the model to the financial return occurs. (*new*)

15. The computer-based method of claim 14, wherein improvement in the fit is determined by a goodness-of-fit criterion comprising a log-likelihood function which is minimized using a conjugate gradient. (*new*)

REMARKS

In the application claims 2-13 are pending and rejected. After due consideration of the Examiner's comments, Applicants have amended the base claims and added new claims which are submitted for consideration. It is respectfully submitted that claims 2-15 as amended overcome all bases for rejection stated in the office action and, therefore, are allowable.

The Examiner comments on Applicants' duty of disclosure and requests additional documentation relating to the inventors' work in 1996/1997. Being filed herewith is a Supplemental Information Disclosure Statement listing numerous publications dated 1996 and later relating to use of the Pixon® method for image reconstruction. Notwithstanding this submission, it is Applicants' position that the Pixon® method is distinct from the invention claimed in the present application. Furthermore, it is submitted that these publications are duplicative and/or cumulative in that they disclose the same Pixon® method disclosed in Patent No. 5,912,993, which is referenced in the specification and was previously cited by Applicants in the Information Disclosure Statement mailed on December 28, 1999. Accordingly, submission of these publications is not an admission by Applicants that this information is material to patentability.

The Examiner requests clarification as to Dr. Piña's relationship to the claimed invention. Applicants respond that Dr. Piña has no relationship to the present invention; that his involvement was in the development of the Pixon® method for image reconstruction, which is distinct from the present invention. (See discussion below relative to the §103 rejections.)

The Examiner requests clarification as to why no government grants are mentioned in the instant application. Applicants respond that the government grants all related to development of a method for <u>image reconstruction</u>, in response to which the Pixon® method was developed. The present invention has nothing to do with image reconstruction and the invention was developed entirely at the expense of assignee, Pixon LLC, with no government funding whatsoever. Accordingly, the government has no interest or rights in the claimed invention.

The Examiner suggests alternate wording for the title. The title has been amended to adopt his suggestion.

The Examiner objects to the abstract. New language is provided which is submitted to be a concise statement regarding the invention.

The Examiner rejects claims 2, 5-8, and 11-13 under 35 U.S.C. §112, first paragraph, and §101 as not being supported by a specific or substantial utility and/or are directed to non-statutory subject matter.

In response, the base claims have been amended to specify application of the claimed invention to prediction in a financial system through analysis of financial return data. As the Examiner did not indicate that claim 3 was rejected under these section, it is submitted that specifying that the data are financial returns overcomes the claim rejections for lack of utility and being directed to non-statutory subject matter.

The Examiner rejects claims 2-13 under 35 U.S.C. §112, 1st paragraph, as containing subject matter not described in the specification. Specifically, the Examiner points to the phrase "measured data points".

In response, the claims have been amended to delete the word "measured."

The Examiner rejects claims 2-13 under 35 U.S.C. §112, 2nd paragraph, as being indefinite. Specifically, the Examiner points to the phrase "predetermined minimum level".

In response, the claims have been amended to change the stated phrase to refer to a selected goodness-of-fit criterion, which is described in the specification at, e.g., page 10, line 7.

The Examiner rejects 2-13 under 35 U.S.C. 103(a) as being unpatentable over various publications of Puetter combined or in combination with MatLab® for Finance.

Each of the Puetter articles identified by the Examiner, as well all of the Puetter articles cited in the accompanying Information Disclosure Statement are specifically drawn to image reconstruction. Note the titles of the publications, which includes "The Pixon Method of *Image Construction*", "Information, Language, and Pixon-Based *Image Reconstruction*", "Pixon-Based Multiresolution *Image Reconstruction* for Yohkoh's Hard X-Ray Telescope", and "The *Image Restoration/Reconstruction* Problem" (*emph. added.*) Other publications not having the word "image" in the title, describe use of the Pixon®

method for reconstruction of images of astronomical bodies obtained from different types of telescopes. Certain of these publications also describe applications of the Pixon® method to analysis of spectra, or to signal encoding or compression. Images, spectra and signals all have physical structure in the sense that they can be broken up into components of the whole. Using images as an example, the source for the image to be reconstructed is typically a detector array consisting of a grid of pixels. The Pixon® elements can be seen as "footprints" overlying the grid to encompass the data contained in one or more pixel in the grid. The locations of the Pixon® elements relative to the grid are then used to create a Pixon® map. The Pixon® map is then used to determine which Pixon® element should be used to model a portion of the input data. (Note that *this* is the invention of Puetter and Piña that is described in Patent No. 5,912,993 as well as the publications describing the Pixon® method.) The only common point shared by the Pixon® method described in the '993 patent and the numerous Puetter publications and the present invention is the concept of *minimum complexity*. (While it is noted that both methods use a goodness-of-fit test, it is implied that virtually any modeling technique must be compared against the original data to evaluate the accuracy of the model.) As stated in the Background of the Invention, the concept of minimum complexity is a manifestation of Ockham's (also spelled Occam's) Razor. This concept dates back to the 14^{th} century and, therefore, is not, in itself, new.

The data analyzed using the present invention is clearly distinct from the type of data that can be analyzed using the Pixon® method. Financial data has no geometric structure, so it cannot be characterized in terms of geometric properties, such as size, area or shape. As a result, it would be impossible to create a "map" in the present invention. The Algebron™ "element" described in the present application is an algebraic parameter in a model. To reduce the algebraic complexity of a model, one discards one or more of these parameters. This is entirely different from the idea of selecting the largest possible Pixon® element, i.e., the element that encompasses the largest amount of data, by trying the largest available element then progressively getting smaller in each iteration until the right goodness-of-fit and signal to noise ratio is attained.

The Pixon® map is an essential component for practicing the Pixon® method. Because the claimed method neither creates nor uses a map of any kind, is would not be

obvious to one of skill in the art to apply the Pixon® method for predicting or analyzing the behavior of a complex system, such as a financial system, which cannot be characterized as having geometric structure. As such, there would be no motivation to combine the Pixon® method with a technique such as MatLab® for Finance. The mere fact that financial prediction software such as MatLab® for Finance exists is insufficient to either motivate or teach one of skill in the art to significantly modify a geometrically-based method such as the Pixon® method to provide for prediction of behavior in an abstract, non-geometric system.

It is submitted that, for the reasons set forth in the foregoing remarks, the amended and new claims are patentably distinct over the cited prior art and, therefore, are in a condition for allowance. Accordingly, the Examiner is requested to withdraw the rejections and allow all claims in the application as amended.

Should the Examiner believe that prosecution of this application might be expedited by further discussion of the issues, he is invited to telephone the undersigned attorney for Applicants at the telephone number listed below.

Respectfully submitted,

Dated: November 14, 2002

By: Eleanor M. Musick

Eleanor M. Musick
Reg. No. 35,623
Attorney for Applicants

Kilpatrick Stockton LLP
1100 Peachtree Street
Suite 2800
Atlanta, GA 30309
Phone: (404) 541-6681
Fax: (404) 541-3317
e-mail: emusick@kilpatrickstockton.com

Attorney Docket No.: 7684-PA01 (46960/251058)